EXECUTIVE SUMMARY

Bechtel Environmental, Inc., has prepared this Feasibility Study (FS) Report on behalf of the Department of the Navy, Southwest Division Naval Facilities Engineering Command, under Contract Task Order 0068, issued under the Comprehensive Long-Term Environmental Action Navy 3 Program, Contract No. N68711-95-D-7526. The Navy follows current United States Environmental Protection Agency (U.S. EPA) guidance for FS report preparation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Title 42 *United States Code* Sections 9601–9675).

Installation Restoration (IR) Site 1, the 1943–1956 Disposal Area, is located on Alameda Point (formerly Naval Air Station [NAS] Alameda). Alameda Point is located on the western tip of Alameda Island, which is on the eastern side of San Francisco Bay (Figure ES-1). IR Site 1 is located in the northwestern corner of Alameda Point (Figure ES-2) and encompasses approximately 78 acres. In September 1993, NAS Alameda was designated for closure by the United States Congress and the Base Realignment and Closure Commission. The base ceased all naval operations in April 1997. The Navy is currently in the process of returning the land to the City of Alameda. On July 22, 1999, Alameda Point was placed on the National Priorities List (NPL) (64 *Federal Register* 140, 39878–39885, Final Rule, July 22, 1999). IR Site 1 is within the NPL-designated area.

This FS Report develops and evaluates remedial action alternatives to mitigate human-health and environmental risks from radiological and nonradiological contaminants in groundwater and soil at IR Site 1. This FS Report does not identify or recommend a preferred remedial alternative. Comments made during public and regulatory agency review of this document will be evaluated during the remedy selection process. As required by the National Oil and Hazardous Substances Contingency Plan (NCP) and U.S. EPA guidance, these comments will also be addressed in a proposed plan as well as in the record of decision (ROD).

Data from recent investigations and analyses for IR Site 1 have been evaluated and incorporated into this FS Report as necessary and appropriate, including data from a 2003 geotechnical and seismic FS for IR Site 1, a 2004 comprehensive surface radiological survey of IR Site 1, groundwater monitoring data collected through spring 2005, and supplemental soil sampling in the beach and burn areas conducted in March 2005.

SITE BACKGROUND

IR Site 1 was operated between 1943 and 1956 as the principal site for waste disposal at NAS Alameda. In addition, aircraft engine parts and vehicles were stored in the northern portion of the site (Figure ES-3). The disposal area reportedly received all waste generated at NAS Alameda except wastewater, which was discharged directly into Seaplane Lagoon via the storm drain system. The current site boundary is shown on Figure ES-3. Accurate estimates of the amounts and types of waste disposed at IR Site 1 are not available. The estimated quantity of solid waste ranges from 15,000 to 200,000 tons. Descriptions of waste materials have included old aircraft engines, cables, scrap metal, waste oil, paint waste, solvents, cleaning compounds, construction debris, ashes from the incinerator located in former Building 68 (demolished in 1961) and low-level radioactive material from the Naval Air Rework Facility.

In 2004, Tetra Tech FW, Inc., performed a wetlands delineation survey of approximately 230 acres at IR Sites 1 and 2 to determine the presence and extent of potential wetlands. The wetlands delineation survey included field evaluation of vegetation, soils, and hydrology of potentially jurisdictional features. The survey identified approximately 18 acres of seasonal wetlands in four areas at IR Site 1 (SW1, SW2, SW3, and SW10) (Figure ES-4). Federal Executive Order No. 11990 requires that federal agencies minimize the destruction, loss, or degradation of wetlands, preserve and enhance the natural and beneficial value of wetlands, and avoid support of new construction in wetlands if a practicable alternative exists.

IR Site 1 is fenced and currently not used. The reuse plan has designated the IR Site 1 area for recreational reuse consisting primarily of a golf course, a beach area, and a shoreline walking path. Additionally, a historic training wall is present along portions of the northern border of IR Site 1. The Alameda Training Wall is a rubble masonry jetty built by the United States Army Corps of Engineers between 1874 and 1896 to "train" the tides to scour a navigational channel between Oakland and Alameda. The Alameda Training Wall, which is also known as the south jetty of the Oakland Inner Harbor Jetties and Federal Channel Historic District, is eligible for listing in the National Register of Historic Places and was placed on the City of Alameda's Historical Building Study List in 2000.

Groundwater beneath the western portion of Alameda Point (including IR Site 1) is not currently used for drinking water, irrigation, or industrial supply. Drinking water is supplied to Alameda Point by the East Bay Municipal Utilities District. The NAS Alameda Base Cleanup Team have concluded that the groundwater beneath IR Site 1 is unlikely to be used as a drinking water source due to the location of the former disposal area over the aquifer.

A fill layer that underlies IR Site 1 is composed of mixtures of sand, silt, and clay, and ranges in thickness from approximately 10 to 30 feet. The fill layer is thinnest in the eastern part of the site. The varying thickness is a result of natural variation in depth of the estuary before filling. In the western portion of the site, refuse has been buried in the fill material. The Bay Sediment Unit (BSU) underlies the fill layer at IR Site 1 and consists of the upper Young Bay Mud underlain in some areas by coarser bay sediments. The Young Bay Mud consists of clay and silt containing mixtures of silt and fine-grained sand.

The shallow hydrostratigraphic units beneath IR Site 1 have been divided into the following four hydrogeologic units:

- first water-bearing zone (FWBZ) – artificial fill layer
- semiconfined aquitard – Young Bay Mud of the BSU
- second water-bearing zone (SWBZ) – lower portion of the BSU, Merritt Sand and Upper San Antonio Formation
- regional aquitard – Lower San Antonio Formation, including the Yerba Buena Mud

The FWBZ at Alameda Point is unconfined and located in the fill material. This FWBZ in the fill layer is a local feature of Alameda Point and is not present regionally. Depth to groundwater in the FWBZ at IR Site 1 ranges from the ground surface to approximately 8 feet below ground surface (bgs) and averages 3 to 5 feet bgs. Groundwater generally flows toward the shoreline in

the FWBZ at IR Site 1 (west toward the San Francisco Bay and north toward the Oakland Inner Harbor).

Previous investigations have identified a groundwater plume present in the FWBZ in the central western portion of IR Site 1 (Figure ES-5). Groundwater investigations have primarily reported volatile organic compounds (VOCs) in this plume area; however, petroleum hydrocarbons, semivolatile organic compounds, and metals have also been reported. The presence of dense nonaqueous-phase liquid (DNAPL) in the form of widespread dispersed droplets and/or ganglia is suspected.

GROUNDWATER AND SOIL STUDY AREAS

Based on results of previous investigations, the groundwater at IR Site 1 has been divided into the following three areas for focusing discussions in this FS Report:

- VOC plume area
- FWBZ outside the VOC plume area
- SWBZ area

To focus discussions regarding soil, IR Site 1 has been divided into five geographic areas (Figure ES-4) plus a sitewide area for radium-impacted waste.

- Area 1 is the former disposal area. Area 1 is subdivided into Areas 1a and 1b; Area 1b is the former burn area and Area 1a is the remainder of Area 1. Seasonal wetland SW1 and a portion of seasonal wetlands SW2 and SW10 are located in Area 1.
- Area 2 consists of the paved areas (i.e., runways, taxiways, and aprons) outside the former disposal area; Area 2a is located east and south of Area 1, and Area 2b is located north of Area 1.
- Areas 3a and 3b are unpaved areas located outside the former disposal area, on either side of Area 2a. Seasonal wetland SW3 and a portion of seasonal wetland SW2 are located in Area 3a, and most of seasonal wetland SW10 is located in Area 3b.
- Area 4 is the firing-range berm; it is located within the boundaries of Area 1.
- Areas 5a and 5b are located at the shoreline along the western and northern site boundaries, respectively.
- The area for radium-impacted waste extends over the entire site.

GENERAL RESPONSE OBJECTIVES

General response objectives are used to identify remedial action objectives (RAOs). The general response objectives for IR Site 1 are as follows.

- Protect human health by preventing transferee exposure to groundwater chemicals of concern (COCs) from recreational use of the site until the Navy, U.S. EPA, California Environmental Protection Agency Department of Toxic Substances Control (DTSC), and the San Francisco Bay California Regional Water Quality

Control Board (RWQCB) concur that there is no longer an unacceptable risk from such exposure.

- Protect human health by preventing future recreational receptor exposure to soil COCs (including radium-impacted waste) and potential munitions and explosives of concern posing unacceptable risk until the Navy, U.S. EPA, DTSC, and the San Francisco Bay RWQCB concur that there is no longer an unacceptable risk from such exposure.
- Protect existing beneficial uses of surface water adjacent to IR Site 1, including protection of ecological receptors.
- Prevent unacceptable exposure of terrestrial ecological receptors to contaminants and mitigate impacts to existing wetlands and related upland habitats at IR Site 1 to the extent possible in the context of the CERCLA remedial action.

DATA GAPS IDENTIFIED DURING FEASIBILITY STUDY PROCESS

The RI for IR Site 1 was completed under the assumption that the entire surface of IR Site 1 would be capped. For this reason, characterization of the soil, groundwater, and waste material in all areas of IR Site 1 was not as extensive as is customary for IR sites that may not be capped. Several data gaps for IR Site 1 have been identified during the FS process. The data gaps and the plan for providing the needed information are as follows:

- **Delineation of TCE in groundwater at well M002-A.** TCE has been reported in groundwater samples from well M002-A at concentrations below RAOs. The lateral extent of TCE in this area has not been defined. At the latest, this will be investigated as part of the remedial design phase; however, it may be investigated sooner.
- **Analysis for 1,4-dioxane in groundwater using lower detection limit.** Groundwater samples collected in May 2000 were analyzed for 1,4-dioxane using a reporting limit of 200 µg/L. All remedial alternatives evaluated for groundwater in this FS Report include analysis for 1,4-dioxane in groundwater using a lower reporting limit for samples collected during the initial investigation of the VOC plume area. Information about the presence of 1,4-dioxane in groundwater in the plume area will be available during the remedial design phase of the project.
- **Analysis of groundwater in the burn area for dioxins/furans.** At the latest, groundwater samples will be collected during the remedial design phase from the monitoring wells in the burn area and analyzed for dioxins and furans.
- **Analysis for cyanide in groundwater using a lower detection limit.** Cyanide has not been reported in groundwater samples collected during the most recent year of monitoring. However, the detection limit was 10 µg/L and the laboratory reporting limit ranged from 2 to 4 µg/L. Both the detection limit and the reporting limits were greater than the screening criterion of 1 µg/L. At the latest, groundwater samples will be collected from IR Site 1 monitoring wells and analyzed for cyanide using a detection limit at or below 1 µg/L during the remedial design phase of the project. The data from this sampling will be used to evaluate the exclusion of cyanide from the list of groundwater COCs.

- **Analysis for explosive constituents in groundwater**. Analysis of groundwater samples for constituents indicative of ordnance in FWBZ groundwater will be conducted during the remedial design phase of the project.
- **Radiological survey of the riprap slope areas**. A radiological survey using hand-held instruments will be conducted over the riprap areas of IR Site 1 (where physically possible). Information about the presence of radium-impacted waste in the shoreline areas will be available during the remedial design phase of the project.
- **Assessment of residual impacts in the waste disposal area**. Installation of four interior and/or perimeter wells has been included in all the active groundwater remedial alternatives. Groundwater data from these wells will be available during the remedial design phase of the project and will be used to evaluate groundwater quality in the waste disposal area and assess whether drummed liquids were disposed at IR Site 1.
- **Soil sampling in shoreline areas of IR Site 1**. Confirmation soil sampling is included as part of the remedial alternatives for shoreline areas at IR Site 1. Data from this sampling will be available during the remedial design phase of this project and will be used to determine the extent of hot spot removal along the shorelines.
- **Ecological risk assessment (ERA) for unpaved areas of IR Site 1 outside the disposal area**. An ERA of the unpaved interior areas of IR Site 1 will be performed as part of the remedial alternatives for soil in Area 3. The ERA will consider plants as well as animals. The ERA will be conducted during the remedial design stage of the project and the results of the ERA will be used to determine the extent of the hot spot removals in Area 3.
- **Wetlands evaluation**. An evaluation of the functionality and extent of wetlands in Areas 1 and 3 will be conducted during the remedial design stage for mitigation planning purposes. The final mitigation ratio and amount of mitigation will also be determined at that time based on the location and type of wetlands (preferably in-kind with no net destruction of habitat value).
- **Geotechnical remedy**. The need for a geotechnical remedy will be evaluated in the remedial design stage after waste delineation activities are completed.

If some of the above information is not available for portions of IR Site 1 during the remedy selection phase, the final remedy may need to be modified after the above information is acquired. In that event, an FS addendum might be needed based on results of the data gap investigations.

REMEDIAL ALTERNATIVES FOR GROUNDWATER

Remedial alternatives were developed for groundwater. These groundwater alternatives include combinations of the following remedial technologies: no action, monitored natural attenuation (MNA), monitoring, institutional controls (ICs), excavation and off-site disposal, *in situ* chemical oxidation (ISCO), *in situ* bioremediation (ISB), and zero-valent iron (ZVI) powder injection. The groundwater alternatives are indicated by "GW" followed by the alternative number (e.g. GW1, GW2, etc). Because the contamination in the FWBZ outside the VOC plume area and the contamination in the SWBZ area can be addressed with similar technologies, these

two groundwater areas have been combined for evaluation of remedial alternatives. The title of a groundwater alternative therefore specifies the process options to be applied in the VOC plume area, followed by the process option to be applied in both the FWBZ outside the VOC plume area and in the SWBZ area, followed by a process option to be applied sitewide. For each alternative, the remedial component(s) for each grouping is separated by a double slash (//). If more than one component is included in the remedy for the VOC plume area, the components are separated by a single slash (/). Thus, the remedial components of an alternative are written: process option(s) for the VOC plume area // process option for the FWBZ outside the VOC plume area and for the SWBZ area // sitewide process option. The following retained remedial alternatives were evaluated for groundwater at IR Site 1:

- GW1: No action. As required by the NCP.
- GW2: Source removal/MNA //monitoring // ICs. Removal and off-site disposal of the suspected soils with entrained DNAPL will be followed by MNA in the VOC plume area. Long-term monitoring (30 years) and ICs would be employed for all three groundwater areas.
- GW3: ISCO/MNA // monitoring // ICs. An ISCO approach using Fenton's reagent would be employed to reduce contaminant levels in the VOC plume area, followed by MNA. Long-term monitoring (30 years) and ICs would be employed for all three groundwater areas.
- GW4: ISB/MNA // monitoring // ICs. A semisolid electron donor compound would be injected to induce reductive dechlorination of VOCs in the VOC plume area, followed by MNA. Long-term monitoring (30 years) and ICs would be employed for all three groundwater areas.
- GW5a: ZVI powder injection/MNA // monitoring // ICs. ZVI powder would be injected to induce abiotic reduction of VOCs in the VOC plume area, followed by MNA. Long-term monitoring (30 years) and ICs would be employed for all three groundwater areas.
- GW5b: Source removal/ZVI powder injection/MNA // monitoring // ICs: Excavation and off-site disposal of the suspected DNAPL-entrained soil would be followed by injection of ZVI powder in other areas of the VOC plume to induce abiotic reduction of VOCs. This would be followed by MNA in the VOC plume area. Long-term monitoring (30 years) and ICs would be employed for all three groundwater areas.

These groundwater alternatives were subjected to detailed and comparative analyses. As discussed in Section 6, it is assumed for the purposes of the FS that the remedial technologies retained for the VOC plume area, except those in Alternative GW2, would reduce concentrations in the groundwater to below RAOs in approximately 6 years (the actual time to reach RAOs may be shorter or longer than 6 years). However, it is assumed that long-term monitoring of the FWBZ and SWBZ would be required if the soil alternative chosen for IR Site 1 does not include complete removal of the waste material in Area 1. The present-value costs of Alternatives GW2, GW3, GW4, GW5a, and GW5b were $7.19 million, $5.98 million, $6.05 million, $8.79 million, and $8.67 million, respectively.

The alternatives were subjected to a comparative analysis with regard to the CERCLA balancing criteria, which include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. Alternatives GW3 and GW4 scored equally in satisfying the balancing criteria and slightly higher than Alternative GW5b. Alternatives GW1 and GW5a also scored equally in the balancing criteria; however, Alternative GW1 does not satisfy the threshold criteria of overall protection of human health and the environment. There are trade-offs and uncertainties in the cost and performance of the *in situ* technologies offered by these alternatives, and each includes a pilot-scale testing component. Alternative GW3 offers the most rapid treatment process and addresses a wider range of COCs than Alternatives GW4 and GW5. Alternative GW4 appears to be most implementable. Alternative GW5b is highest in cost and does not appear to offer a significant advantage with respect to the remaining balancing criteria. Alternatives GW4 and GW5a rely on desorption of suspected dense nonaqueous-phase liquid for complete treatment, which could take an extended period of time. However, there is no information to indicate definitively which of these three alternatives would be most effective in the long term.

REMEDIAL ALTERNATIVES FOR SOIL

Remedial alternatives for soil were developed for each of the five geographic areas identified on Figure ES-4 as well as for sitewide radium-impacted waste. Table ES-1 identifies the soil alternatives for these study areas. A total of 24 alternatives for soil remediation in these areas were retained for analysis. These alternatives were analyzed separately, as requested by the regulatory agencies in a December 2004 meeting with the Navy. The following summarizes the approach for soil.

- Soil alternatives for Area 1, the former disposal area, include no action, a soil cover, low-permeability cap, removal of waste in the burn area with a cover or cap for the remainder of Area 1, and complete removal. These soil alternatives for Area 1 constitute the principal element of the remedy for IR Site 1 in terms of scale and cost.
- Soil alternatives for Area 2 include no action, ICs, pavement maintenance with ICs, and a complete removal alternative that includes demolition of the paved surfaces that currently serve to prevent exposure to any potential soil contaminants.
- Soil alternatives for Area 3 include no action, ICs, a Tier 2 ecological risk assessment (ERA), excavation and relocation of hot spot (chemical concentrations above RAOs) soils into Area 1 (under a cover or cap), and off-site disposal of hot spot soils. Most of the seasonal wetlands at IR Site 1 are located in Area 3, and therefore special consideration was given to preserving these areas if possible.
- Soil alternatives for Area 4 include no action, separation of bullets and shell casings from the firing-range berm for recycling, followed by various combinations of the following: relocation of all berm soil underneath the cover or cap in Area 1, relocation of the nonhazardous portion of the berm soil under the Area 1 soil cover, and off-site disposal.
- Soil alternatives for Area 5 include no action and combinations of the following actions: ICs, confirmation sampling; relocation or removal of hot spots from Areas 5a and 5b, and relocation or removal of shoreline debris.

A survey of radiological anomalies was conducted sitewide for IR Site 1 in the summer of 2004. Results of that survey are summarized in Figure ES-6. The radiological survey results show that most of the surface radiological anomalies (indicating the potential presence of radium-impacted waste) reside within the former waste disposal area (Area 1). Alternatives to address radium-impacted waste at IR Site 1 include no action, ICs, removal of radium-impacted waste in Areas 3 and 5 plus one location in Area 1b suspected of being a consolidated radium waste disposal trench, and removal of all radium-impacted waste. Several alternatives for radium-impacted waste rely on the selection of Alternative S1-2 (a soil cover) or S1-3 (an engineered cap). These alternatives would shield receptors from underlying radiological sources in Area 1. An assessment of potential exposure to the radium-impacted waste was conducted as part of this FS Report and indicated that shielding (reduction of external radiation) need not be a controlling factor in the design of a soil cover or cap.

The remedial alternatives for the five soil areas and sitewide radium-impacted waste were subjected to detailed and comparative analyses. Table ES-2 summarizes the estimated cost of the alternatives. The overall rating of the active alternatives (excluding "no action") by CERCLA balancing criteria is summarized as follows.

- **Area 1**. Alternative S1-2: soil cover and ICs; rated highest overall among the balancing criteria. Alternative S1-2 was judged to be the most effective in the short term, the most implementable, and the least costly among the Area 1 remedial alternatives. Alternative S1-3: engineered alternative cap and ICs; rated next highest relative to the balancing criteria.
- **Area 2**. Alternative S2-3: pavement maintenance and ICs; rated highest overall relative to the balancing criteria. Alternative S2-3 was judged to be the most effective in the short term, the most implementable, and the least costly among the Area 2 remedial alternatives. Alternative S2-4: demolition, sampling, hot spot removal, and ICs; rated next highest relative to the balancing criteria.
- **Area 3**. Alternative S3-4: Tier 2 ERA, hot spot relocation, and ICs; rated highest overall relative to the balancing criteria. Alternative S3-4 was judged to be the most effective in the short term and the least costly among the Area 3 remedial alternatives.
- **Area 4**. Alternative S4-2: removal, screening, and relocation; rated highest overall relative to the balancing criteria. Alternative S4-2 was judged to be the most effective in the short term, the most implementable, and the least costly among the Area 4 remedial alternatives. Alternative S4-3: removal, screening, and relocation/off-site disposal; rated next highest overall relative to the balancing criteria, because it was considered more effective in the short term, more implementable and lower in cost than Alternative S4-4. Alternative S4-4: removal, screening, and off-site disposal; rated lowest relative to the balancing criteria.

- **Area 5**. Alternative S5-3: confirmation sampling and ICs; rated highest overall relative to the balancing criteria. Alternative S5-3 was judged to be the most effective in the short term, the most implementable, and the least costly among the Area 5 remedial alternatives. Alternative S5-4: confirmation sampling, hot spot relocation, and ICs; rated next highest relative to the balancing criteria. Alternative S5-4 was considered more effective in the short term than Alternative S5-6. Alternative S5-6: confirmation sampling, hot spot removal, shoreline debris removal, and ICs; more implementable and lower in cost than Alternatives S5-5 and S5-6. Alternative S5-5: confirmation sampling, hot spot relocation, shoreline debris relocation, and ICs; along with Alternative S5-6, rated lowest relative to the balancing criteria.
- **Sitewide area for radium-impacted waste**. Alternative S6-4: removal of radium-impacted waste in Areas 3 and 5, and in one location of Area 1, and cover/cap remaining radium-impacted waste in Area 1; rated highest overall relative to the balancing criteria. Alternative S6-4 was judged to be more effective in the short term, more implementable, and less costly than Alternative S6-5 (removal of all radium-impacted waste).

POTENTIAL SITEWIDE REMEDIAL ALTERNATIVES

In order to illustrate a representative range of sitewide remedial actions and costs, potential sitewide alternatives have been compiled (Table ES-3). These potential sitewide alternatives are presented merely for discussion purposes and should not be construed as recommendations. The alternatives have been assembled to give the reader an indication of the overall range in possible costs. Alternative 1 (no action) would have no cost. Alternative 2 represents the least costly active soil and groundwater alternatives. Alternative 7 represents the most costly soil alternatives, and would include no action for groundwater on the presumption that the groundwater in the VOC plume area would be dewatered and the contaminant sources removed during complete removal of the waste material from Area 1. These sitewide alternatives range from $12.9 to $121 million in present-value costs (Table ES-3). These costs do not include the geotechnical and seismic remedy recommended in the 2003 geotechnical and seismic FS Report.

CONCLUSION

This FS Report presents a sufficient number and range of remedial alternatives to enable the project to move to the remedy selection phase. Uncertainties in site conditions that could affect overall cost are identified in this FS Report; however, the FS alternatives present a range of conceptual options which are intended to address uncertainties as necessary and appropriate (e.g., additional groundwater investigation, geophysical investigation, confirmation sampling and analysis, and/or excavation of test pits). It is envisioned that these tasks would be performed following remedy selection, as appropriate to the specific remedy selected. If necessary, the current uncertainties in site conditions could be addressed during the remedy selection phase of the project through contingency provisions in the ROD.